ORGANIC FUEL CELL, AND METHODS OF OPERATION THEREOF AND MANUFACTURE OF ELECTRODE THEREFOR

Claims of **WO9612317**

Translate this text

What is claimed is:

1. In a liquid feed direct fuel cell having an anode, a cathode, an electrolyte, means for circulating an organic fuel past the anode and means for circulating oxygen past the cathode, an improvement comprising:
employing a solid polymer electrolyte membrane as the electrolyte; and
providing an organic fuel which is substantially free of an acid electrolyte.

2. The improvement of claim 1, wherein said membrane is a solid proton exchange membrane.

3. The improvement of claim 2, wherein said membrane is composed of NafionTM.

4. The improvement of claim 2, wherein said membrane is composed of modified perfluorinated sulfonic acid polymer.

5. The improvement of claim 2, wherein said membrane is composed of polyhydrocarbon sulfonic acid polymer.

6. The improvement of claim 2, wherein said membrane is composed of a composite of two or more proton exchange membranes.

7. The improvement of claim 1, wherein said organic fuel is selected from a group consisting of methanol, formaldehyde, and formic acid.

8. The improvement of claim 1, wherein said organic fuel is selected from a group consisting of dimethoxymethane, trimethoxymethane and trioxane.

9. The improvement of claim 1, wherein said anode is a commercial electrode impregnated with a hydrophilic proton conducting water-insoluble ionomer.

10. The improvement of claim 9, wherein said ionomer is NafionTM.

11. The improvement of claim 9, wherein said ionomer is montmorrolinite clay.

12. The improvement of claim 9, wherein said ionomer is an alkoxycellulose.

13. The improvement of claim 9, wherein said ionomer is a cyclodextrine.

14. The improvement of claim 9, wherein said ionomer is a mixture of zeolites.

15. The fuel-cell of claim 9, wherein said ionomer is zirconium hydrogen phosphate.

16. A liquid feed fuel cell, comprising:
an anode;
a cathode;
a solid polymer electrolyte membrane disposed between said anode and said cathode;
means for circulating a liquid organic fuel and water solution past said anode, said solution being substantially free of sulfuric acid; and
means for circulating oxygen past said cathode.

17. A liquid feed fuel cell, comprising:
an anode impregnated with a hydrophilic proton conducting water-insoluble ionomer;

a cathode;
a polymer electrolyte membrane disposed between said anode and said cathode;
means for circulating a liquid organic fuel and water solution past said anode; and
means for circulating oxygen past said cathode.

18. The fuel cell of claim 17, wherein said membrane is a solid proton exchange membrane.

19. The fuel cell of claim 18, wherein said membrane is composed of NafionTM.

20. The fuel cell of claim 18, wherein said membrane is composed of modified perfluorinated sulfonic acid polymer.

21. The fuel cell of claim 18, wherein said membrane is composed of polyhydrocarbon sulfonic acid polymer.

22. The fuel cell of claim 18, wherein said membrane is composed of a composite of two or more proton exchange membranes.

23. The fuel cell of claim 17, wherein said organic fuel is selected from a group consisting of methanol, formaldehyde, and formic acid.

24. The fuel cell of claim 17, wherein said organic fuel is selected from a group consisting of dimethoxymethane, trimethoxymethane and trioxane.

25. The fuel cell of claim 17, wherein said ionomer is
NafionTM.

26. The fuel cell of claim 17, wherein said ionomer is montmorrolinite clay.

27. The fuel cell of claim 17, wherein said ionomer is an alkoxycellulose.

28. The fuel cell of claim 17, wherein said ionomer is a cyclodextrine.

29. The fuel cell of claim 17, wherein said ionomer is a mixture of zeolites.

30. The fuel cell of claim 17, wherein said ionomer is zirconium hydrogen phosphate.

31. A liquid feed fuel cell, comprising:
a housing having an anode chamber and a cathode chamber;
a NafionTM polymer electrolyte membrane mounted within said housing and separating said anode and cathode chambers;
a cathode formed on a side surface of the membrane facing the cathode chamber;
an anode formed on an opposing side of the membrane facing the anode chamber, said anode being impregnated with
NafionTM;
means for circulating a liquid organic fuel and water solution past said anode;
means for circulating oxygen past said cathode
means for withdrawing carbon dioxide from the anode chamber; and
means for withdrawing oxygen and water from the cathode chamber.

32. An electrode comprising a metal alloy impregnated with a hydrophilic water-insoluble proton conducting ionomer.

33. A method for processing a carbon structure composed of high-surface area carbon particles supported by binder, said method comprising the steps of:
immersing the carbon structure within a bath containing a liquid perflourinated sulfonic acid polymer; and
removing and drying said carbon structure.

34. The method of claim 33, wherein said polymer is a 1% NafionTM solution within methanol.

35. The method of claim 33, wherein said step of immersing said carbon structure in a bath containing a

liquid polymer is performed for 5 to 10 minutes.

36. A structure processed according to the method of claim 33.

37. In an electro-deposition bath for use in fabricating an electrode for use in a liquid feed fuel cell, an improvement comprising adding a quantity of perfluorooctanesulfonic acid to said bath.

38. A method for fabricating an electrode for use in a fuel cell, said method comprising the steps of:
providing a bath containing a solution of metallic salts dissolved in sulfuric acid;
adding perfluorooctanesulfonic acid to said bath;
positioning a high-surface-area carbon electrode structure within said bath;
positioning an anode within said bath; and
applying a voltage between said anode and said electrode until a desired amount of metal becomes deposited onto said electrode.

39. The method of claim 38, wherein said metal salts include hydrogen hexachloroplatinate and potassium pentachloroaquoruthenium.

40. The method of claim 38, wherein said anode is composed of platinum.

41. The method of claim 38, wherein said carbon electrode structure includes carbon combined with a TeflonTM binder.

42. The method of claim 38, wherein said carbon electrode includes high-surface-area carbon bound by a 15 %, by weight, TeflonTM binder and applied on a carbon-based fiber layer.

43. The method of claim 38, wherein said acid is provided with a concentration in the range of 0.01 - 0.05 M.

44. The method of claim 38, including the further steps of extracting said electrode from said bath and washing said electrode in deionized water.

45. A method for fabricating an electrode having metal ions deposited thereon for use in a liquid organic fuel cell, said method comprising the steps of:
providing a bath comprising a solution of hydrogen hexachloroplatinate and potassium pentachloroaquoruthenium dissolved in sulfuric acid, wherein said hydrogen hexachloroplatinate and potassium pentachloroaquoruthenium has a concentration in the range 0.01 - 0.05 M;
adding perfluorooctanesulfonic acid to said bath, with a concentration within the range of 0.1 - 1.0 grams / liter;
positioning a high-surface area carbon electrode structure into said bath, wherein said carbon electrode structure has a mixture of carbon particles with a surface area of about 200 meters/gram a TeflonTM binder, with the mixture applied to a fiber-based carbon paper;
positioning a platinum anode into said bath; and
applying a voltage between said anode and said electrode until a desired amount of platinum and ruthenium become deposited onto said electrode.

46. An electrode fabricated according to the method of claim 45.

47. In a liquid feed fuel cell, an improvement comprising adding a quantity of perfluorooctanesulfonic acid to a fuel of the fuel cell.

48. The improvement of claim 47, wherein said perfluorooctanesulfonic acid is provided with a concentration of at least 0.0001 M.

49. The improvement of claim 48 wherein said perfluorooctanesulfonic acid is in the range 0.0001 M to 0.01 Molar.

50. A liquid feed fuel cell, comprising:
an anode;
a cathode;
means for circulating a liquid organic fuel, water, acid electrolyte and perfluorooctanesulfonic acid additive

solution past said anode; and
means for circulating oxygen past said cathode.

51. A liquid feed fuel cell, comprising:
an anode;
a cathode;
an electrolyte;
means for circulating a liquid organic fuel selected from a group consisting of trioxane, dimethoxymethane, and trimethoxymethane past said anode; and
means for circulating oxygen past said cathode.

52. The fuel cell of claim 51, wherein said fuel is dissolved in water to a concentration of between 0.1 and 2.0
M.

53. A method for generating energy comprising the steps of:
providing a liquid-feed fuel cell; and
operating the liquid-feed fuel cell using an organic fuel selected from a group consisting of trioxane, dimethoxymethane and trimethoxymethane.
